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THE INFLUENCE OF SCHOOL EATING ENVIRONMENT ON CHILDREN'S EATING
BEHAVIORS: AN EXAMINATION OF THE SNDA-III

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ACKNOWLEDGEMENTS

I would like to thank Sara Paton and Sylvia Ellison for all their assistance and support throughout this project. You both enthusiastically encouraged me to continue looking at this issue and saw its importance to all our children. Sylvia, thank you for all your patience throughout the data cleaning and analysis phase.

I would also like to thank my husband Grant for his support through this project. Being able to brainstorm ideas and analysis strategies with him was incredibly valuable. Grant, I also appreciate and marvel at your ability to somehow convince the contractors to send a copy of the data, after all my attempts at requesting the data failed.

Finally, I would like to thank my daughter Jordan for putting up with my hundreds of questions about the lunches she and her friends take to school and about the food and eating environment in her own school cafeteria.

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THE INFLUENCE OF SCHOOL EATING ENVIRONMENT ON CHILDREN'S EATING BEHAVIORS: AN EXAMINATION OF THE SNDA-III

ABSTRACT

The prevalence of childhood overweight and obesity in the United States has prompted researchers to examine the factors that contribute to children's food choices and consumption. Schools provide ample opportunities to teach children healthy eating habits, as well as create eating environments that are conducive to healthy eating behaviors. The National School Lunch Program (NSLP) provides federally assisted meals to millions of children every day and the assessment of the NSLP provides an opportunity to examine the school-eating environment. Hierarchical and logistic modeling of the SNDA-III, the USDA assessment of the NSLP, was conducted to determine relationships between environmental factors and children's consumption of the two food items for which most children should increase and decrease consumption. Results suggest that children's consumption of fruits and vegetables is significantly related to the cleanliness of the cafeteria floors, whether a food service staff member spoke to a parent group, and whether the child purchased a sweet food item to accompany his or her meal. Children's dessert consumption was significantly related to the school's nutrition policies in food purchasing and whether the child brought lunch from home or acquired it at school. Limitations of the SNDA-III data created challenges to a comprehensive analysis of the role of the school eating environment on children's food consumption and more research and work is needed to develop a more relevant assessment of the influence of environment on food consumption.

INTRODUCTION

Childhood overweight and obesity is recognized as one of the most significant health problems of our generation. The U.S. Centers for Disease Control and Prevention (CDC) reports that based on the NHANES surveys (1976-1980 and 2003-2006), childhood obesity has increased from 5.0% to 12.4% for two- to five-year-olds, from 6.5% to 17% for six to eleven-year-olds, and from 5.0% to 17.6% for twelve- to nineteen-year-olds (Centers for Disease Control and Prevention, 2009). Healthy People 2010 identified overweight and obesity in both children and adults as a leading health indicator, assigning greater priority to the reduction of rates in the U.S. (Healthy People 2010, 2000). The Healthy People 2010 target for childhood overweight and obesity was five percent (Lyles, 2009), far lower than the actual U.S. rate. The World Health Organization (WHO) has defined childhood obesity as one of the “most serious public health challenges of the 21st century” (World Health Organization, 2009).

Childhood obesity contributes to an increased risk of chronic health conditions both immediately and in the longer term. Overweight and obese children have a higher risk for high blood pressure, Type 2 diabetes, and other cardiovascular problems as children. Overweight children have a higher risk of becoming overweight adults and suffering from cardiovascular disease and cancer, and shortening of life expectancy (Centers for Disease Control and Prevention, 2009). According to WHO (2009), over 2.6 million people worldwide die every year from causes attributable to overweight and obesity. Direct and indirect costs of obesity total more than \$100 billion annually (Herper, 2007). Health risk behaviors, such as poor diet and lack of physical activity, are often formed during youth and adolescence and contribute both to poor health status as an adolescent and as an adult (Lee, 2009).

Overweight is a multi-dimensional problem that is created and exacerbated through the interaction of genetic, social, environmental, biological, behavioral, and policy factors that result

in an obesogenic infrastructure that encourages energy imbalance (Katz, 2009; Lyles, 2009). Reducing overweight among children requires understanding the factors that influence children's eating and exercise behaviors and creating interventions that address the variety of environments that encourage unhealthy behaviors. Individual factors may partially explain why a child is, or is not, overweight, but given the prevalence of overweight and obesity across the population of U.S. children, understanding the full picture of child overweight requires an examination of structural factors that contribute to children choosing unhealthy behaviors (Cohen et al., 2000; Rose, 2008).

Health professionals are starting to understand the potential for influencing children's food consumption and physical activity levels during the school day (Wechsler et al., 2000). Children spend many hours a day in the school environment and eat at least one, and sometimes two, meals while at school. Schools have the opportunity to teach children the knowledge and skills they need to make decisions about food consumption and physical activity that set the stage for a lifetime of health-promoting behaviors. The school also provides a social environment in which norms of appropriate behaviors are communicated and encouraged.

Researchers have studied both individual factors that contribute to a child's nutrition and physical activity and structural factors that create healthy and unhealthy school environments (Finkelstein et al., 2008); however, little research has brought the two together to investigate how the environment influences individual behaviors. A holistic approach to examining the influence of the school environment provides a richer picture of the factors that contribute to children's health.

STATEMENT OF PURPOSE

This study expands the examination of eating environment to include not only the presence of competitive foods, but also atmospheric and food service variables. Additionally, this study takes the examination further by analyzing the relationships between environmental factors and children's eating behaviors. This project will contribute to the body of knowledge related to understanding children's eating behaviors and the factors that influence these behaviors. The project will also contribute to public health by identifying environmental factors that influence children's health behaviors so that appropriate interventions may be developed.

REVIEW OF LITERATURE

This project is based on ecological theory that proposes structural factors of the environment as critical determinants of individual health and behavior (Cohen et al., 2000). According to Cohen et al. (2000), these structural factors can be categorized as factors related to (1) availability/accessibility, (2) social structures, (3) physical structures, and (4) cultural/media messages. These factors can influence individual behavior singly, or most likely, in combination. Ecological theory is also related to Social Cognitive Theory that explains how the interrelationships between an individual and his or her environment affect behavior (Bandura, 1986).

The U.S. Department of Health and Human Services recognizes the social and environmental influences on health through its Determinants of Health model (see Figure 1) and through its Healthy People objectives. In this model, health is determined by the interactions of four factors: an individual's behavior, the social environment, an individual's biology or genetic predispositions to disease, and the physical environment. These four determinants are influenced at the societal level by policies and interventions implemented by the government or organizations, as well as an individual's access to quality health care.

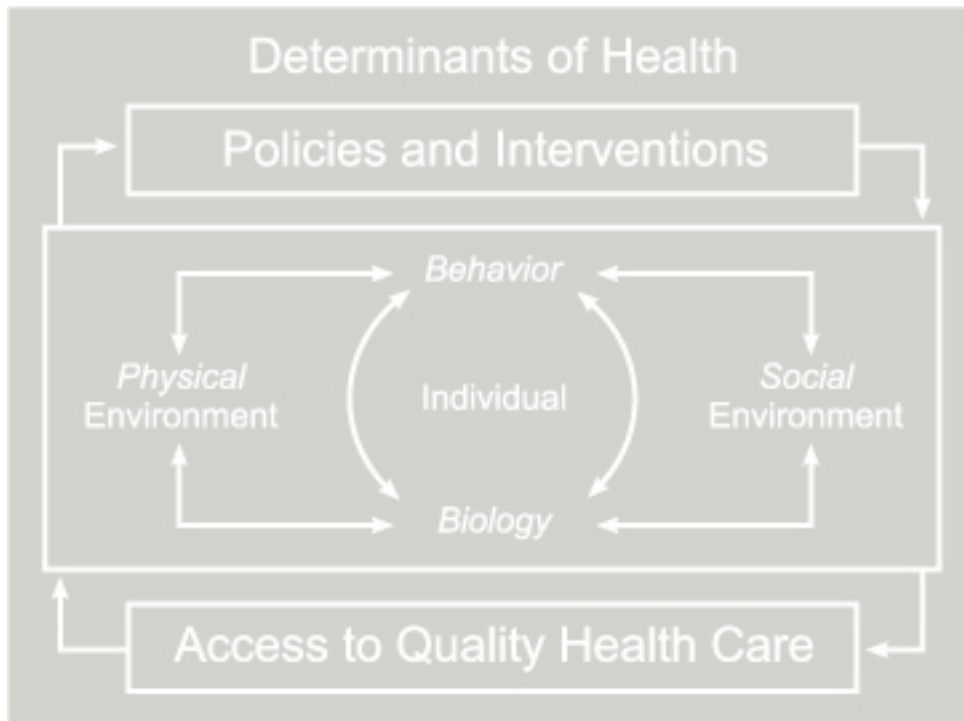


Figure 1. Determinants of Health Model. <http://www.healthypeople.gov>

For children, school serves as both a physical and social environment. School provides the physical environment within which behaviors are learned and enacted, and simultaneously provides a social environment in which children and adults interact and influence each other. The school environment is highly regulated by federal, state, and local policies that impact educational instruction, teacher hiring, funding, food provision, and environmental/occupational health and safety.

The Role of the School in Health Education

Schools have a unique, and necessary role to play in addressing children's health-risk and health-promoting behaviors. Most U. S. children consume a significant portion of their daily calories, one-third to one-half, while they are at school (Briefel, Wilson, & Gleason, 2009; Clark & Fox, 2009; Condon, Crepinsek, & Fox, 2009; Crepinsek et al., 2009; Gleason & Dodd, 2009; Lee, 2009). Schools have an opportunity, through the provision of school meals, to help children

develop lifelong healthy eating behaviors ((IOM, 2007; Katz, 2009; Levine, 2008). School food programs control the choices and access that children have to certain foods and have the ability to expose children to more or less healthy options.

Health and physical education classes can teach children the skills they need to maintain health-promoting behaviors, but the school also provides an environment in which children learn norms related to health behaviors. Schools convey the impression of the importance, or lack thereof, of diet and physical activity that can affect children's behaviors beyond the school setting (Katz, 2009). Children's healthy lifestyle behaviors are influenced through policies that make certain foods more or less accessible, policies regarding physical activity, and by influencing social norms indirectly through culture, and directly through education (Wechsler et al., 2000).

School Meal Programs

The National School Lunch Program (NSLP) and the School Breakfast Program (SBP) are federal programs administered by the U.S. Department of Agriculture (USDA) that provide subsidized meals to school age children (Gordon et al., 2009; Gunderson, 2003; Levine, 2008). Results of a recent study concluded that almost half (49.2%) of U.S. children will at some point between the ages of one and 20, live in a home that receives food stamps (Rank & Hirschl, 2009). Families who qualify for food stamps also qualify for free or reduced school meals so most of these children who may already suffer from food insecurity will depend upon school meal programs to provide a substantial portion of their daily nutritional needs. Additionally, children who do not qualify for free or reduced lunches may participate in the program by paying the full price designated by the school; however, their meals are partially subsidized as well.

Most public, and some private, schools in the United States participate in the National School Lunch (NSLP) and School Breakfast Programs (SBP). These programs represent one of the largest federal programs that directly impact children's health; approximately \$9.3 billion was spent in 2008 to feed 30 million children in this country every school day (Poppendieck, 2010; USDA Food and Nutrition Service, 2009). The Child Nutrition Act is due for reauthorization in 2010, at which time the U.S. Congress will determine new federal budget appropriation levels and any changes to the program.

Meal planning is conducted at the school district or individual school level, but generally, a lunch meal provided through the NSLP program includes milk, a source of protein, breads/grains, and fruits and vegetables, and is expected to provide 33% of a child's Recommended Daily Allowance (RDA) for energy and nutrients (Crepinsek et al., 2009; Gordon et al., 2009; Institute of Medicine of the National Academies [IOM], 2007).

The NSLP and SBP are often not the only sources of food for children at school; many children also have the opportunity to purchase food at school from competitive sources such as a la carte sales, vending machines, school stores, concession stands, fundraisers, and to receive food as rewards for behavioral or academic incentives (Finkelstein, Hill & Whitaker, 2008; IOM, 2007; Levine, 2008). These foods are not usually subject to the same nutritional guidelines and may serve as supplements, or replacements, for foods that do meet federal guidelines for the NSLP and SBP.

The Eating and Food Environment

Healthy eating is not only a factor of the nutritional quality of foods selected and consumed but also the environment within which the selection and consumption takes place. Food choices are not made in isolation, but are influenced by the environment and its many

contexts and influences (Story et al., 2008). Ecological theories propose that health behavior is influenced both by individual factors such as cognitions, emotions, and demographics, and by social-structural characteristics, policies, and practices of the larger environment (Story et al., 2008).

Some schools attempt to influence children's health-promoting behaviors by regulating the macro-level school environment to encourage more health-promoting behaviors in both children and their families. Katz's (2009) review and meta-analysis of school-based interventions for weight control suggests that the most common strategies include: (1) reducing access to junk food, soda, and sports drinks, (2) providing healthful foods in the cafeteria and vending machines, (3) incorporating daily physical activity, (4) teaching principles of good nutrition, (5) teaching practical skills for achieving good nutrition, (6) developing programming that reaches into households, (7) developing programming that relies on youth leadership and peer training, (8) making fresh fruits and vegetables available daily, (9) incentivizing out-of-school healthful eating and physical activity, and measuring children's body mass index.

Other researchers have looked specifically at the micro-level factors inherent in the eating environment and how those factors influence food selection and consumption. Wansink (2004) divides environmental influences into those related to the *eating* environment, such as atmospherics, effort, social interactions, and distractions, and those related to the *food* environment, such as portion size, presentation, salience, and how food is served. Both types of environmental factors influence eating because they suggest consumption norms and inhibit monitoring of how much has been eaten. Wansink's (2004) research found that people use social and environmental cues in the eating environment to determine when to start and stop eating, rather than using physiological hunger cues. The mere presence or salience of food, being with

other people, or even environmental cues (the lunch bells at school) can provide cues to begin and end eating. Atmospheric characteristics such as lighting, odor, noise, and music create a more or less desirable consumption experience. The social environment can also affect what and how much is eaten during a meal as subtle consumption norms are validated or discouraged. Distractions also prevent people from monitoring the volume of their eating.

The food environment also influences consumption. The presence (salience) of a food can provoke perceived hunger, and perceived variety often encourages greater consumption (Wansink, 2004). Portion sizes imply appropriate consumption volumes and portion size increases in the U.S. correlate with increased caloric consumption. Some researchers suggest that portion sizes begin to influence children's consumption volume between the ages of three and five (Fisher et al., 2003). Many of these eating and food environment factors that influence consumption are prevalent in the school environment and may have a significant impact on children's eating behaviors.

Cohen et al. (2000) argued that if prevalence of high-risk health behaviors is great, and if the goal of a health intervention is to influence as many people as possible, then the focus of the intervention should be on the environment, rather than individual behavior. These authors conceptualized the environment as structural factors that influence population-level health behaviors such as: (1) availability of protective or harmful consumer products, (2) physical structures or characteristics, (3) social structures and policies, and (4) media and cultural messages (Cohen et al., 2000).

Within a school eating environment, the first factor, availability of harmful or protective foods, influences children's eating behavior. The presence of competitive foods makes it easy for students to choose less healthy options. The presence of energy dense, processed foods increases

salience and desire for these foods and reinforces consumption norms about the appropriateness of these types of foods in a child's diet. Kubik et al.'s (2003) 24-hour dietary recall study of middle-schoolers found that the availability of a la carte food in the school was inversely related to fruit and fruit/vegetable consumption and was positively correlated with fat intake. There was also an inverse relationship between snack food vending machine availability and fruit consumption. Wang et al.'s (2008) analysis revealed an increase in U.S. children's consumption of sugar sweetened beverages and fruit juice between 1988-1994 and 1999-2004 to approximately 10 - 15 percent of total calories. While most of the consumption occurred in the home, seven to 15 percent of consumption occurred in school settings.

The second factor, physical structures or characteristics, influences the situation in which a child eats and may contribute to more or less attention paid to food consumption. Noise, availability of seating, and distractions create a more or less desirable eating environment. A less desirable eating environment, particularly if lunch is followed by a more desirable activity such as recess, may encourage children to eat their meal faster or to prioritize "well liked" foods over more nutritious choices. When children are not allowed the option of recess when finished with lunch, the longer time period and distractions may encourage some children to consume more food however.

Social structures and policies influence children's eating behaviors by requiring or prohibiting certain behaviors. Within a school lunch environment, children may be restricted from talking to each other, moving around the room, selecting their own seating, consuming certain foods or exchanging food. Children who violate these rules may be isolated from their peers for subsequent meals or may receive other types of punishments. While social structures

and policies can influence behavior, they may do so only out of coercion and not through true knowledge or attitude change.

Media and cultural messages affect children's eating behaviors. Children arrive at school having been exposed to heavy marketing efforts by food companies. Children demonstrate high brand awareness and desire and know the norms of "acceptable" foods for school meals. Some schools have pouring rights contracts and contracts with branded foods and restaurants, increasing the availability of these foods to children and increasing the validation of these foods as appropriate for a meal situation. Promotional materials featuring well-known celebrities may appear in school cafeterias, encouraging children's consumption of these items. The Institute of Medicine (IOM) Committee on Food Marketing to Children and Youth published a thorough review of evidence concluding that food and beverage marketing to children was influential in children's food choices and that it was not consistent with nutritional recommendations for children's diets (IOM, 2006).

The U. S. Department of Agriculture's (USDA) report, *Changing the Scene: Improving the School Nutrition Environment* (2000) expanded its recommendation of desired changes to school food programs to include environmental/ecological factors in addition to providing quality school meals. *Component 3: Other Healthy Food Options* recommends that schools implement policies to include nutrition standards for competitive foods, restrictions on availability and marketing of competitive foods, and discouraging the use of food as a reward or punishment. *Component 4: Pleasant Eating Experiences* recommends that meal periods be long enough for students to eat and that recess is scheduled before lunch, that schools encourage socializing among children and adults during meals but within appropriate noise limits, that facilities are designed to provide enough serving lines to reduce wait time, and that enough

appropriately-sized seating is available. Schools should also consider availability of hand-washing facilities and drinking fountains for students and prioritize aesthetics and functionality of kitchen and dining areas, lighting, open space, windows, materials, and safety in renovations and construction.

Finkelstein and his colleagues (2008) examined the SNDA-III data and created a food environment summary score to categorize U.S. schools. These researchers constructed an index of binary variables assigned to availability of competitive foods, nutrient content of school lunches, and district or school policies and practices. They examined the index scores in relation to school characteristics and concluded that as children move from lower to higher grades, the school food environments become less healthy. Competitive foods are widely available in higher grades and are often of low-nutrient quality.

METHODS

This research is a secondary analysis of the data collected from food service managers, principals, students, and parents who participated in the third School Nutrition Dietary Assessment (SNDA-III). The School Nutrition Dietary Assessment (SNDA) was developed in the early 1990s as a cross-sectional evaluation of the NSLP and SBP. The assessment has been conducted three times. The most recent cross-sectional, nationally representative survey (SNDA-III) was conducted by Mathematica Policy Research, Inc. (Princeton, NJ) from January through August 2005.

Research Questions

Because few previous studies have examined the relationships between the eating environment, individual factors, and a child's selection and/or consumption of certain foods, this project was exploratory in nature and tested the following research questions:

1. What is the nature of the relationships between the physical eating environment, social eating environment, availability of competitive foods, availability of healthy foods, school nutrition policies, health and wellness policies, cultural norms, child's age, gender, and BMI percentile, food source, and grade level of the school, and a child's consumption of fruit, 100% juice, or vegetables?
2. What is the nature of the relationships between the physical eating environment, social eating environment, availability of competitive foods, availability of healthy foods, school nutrition policies, health and wellness policies, cultural norms, child's age, gender, and BMI percentile, food source, and grade level of the school, and a child's consumption of dessert?

A social-ecological perspective was utilized, examining the hierarchical, individual, and interactive relationships between the influencing factors and a child's consumption of either fruits and vegetables, or dessert (see Figure 2). Fruit/vegetable and dessert consumption were selected as the dependent variables to reflect the most- and least-desired food choices for children. Meat and milk consumption was not chosen because of the inability to differentiate whether the child selected the most healthy (low fat) selection or least healthy (high fat) selection

Variables

Dependent Variables

Consumption of fruit, 100% juice, or vegetable

Consumption of dessert

Independent Variables

Physical eating environment

Social eating environment

Availability of competitive foods

Availability of healthy foods

Nutrition policies

Overall health and wellness policies

Cultural norms

Child's age

Child's gender

Child's BMI Percentile

Source of food

Grade level of school

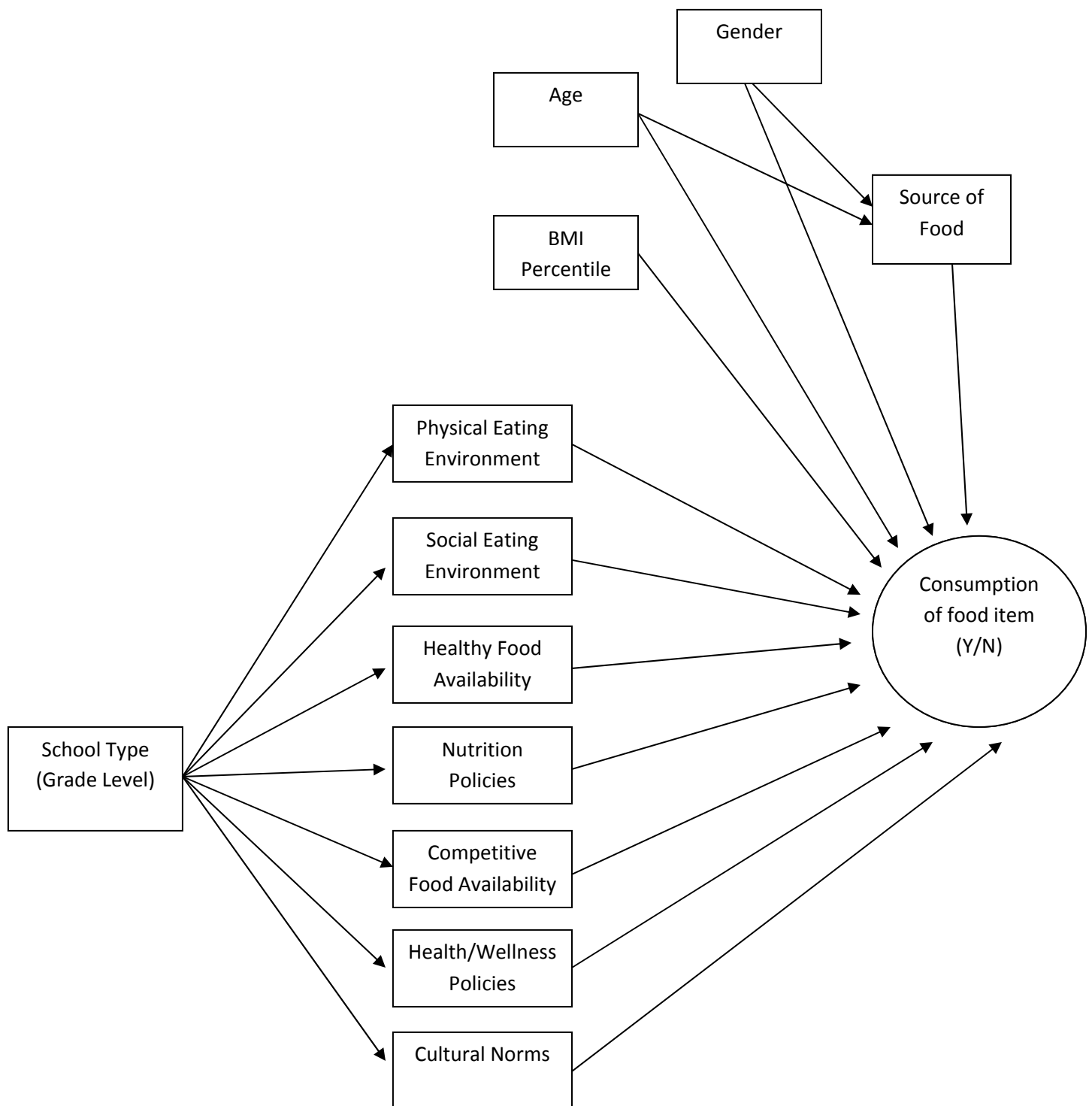


Figure 2. Research Model

Sampling Plan

School officials, students, and parents are surveyed in the School Nutrition Dietary Assessment (SNDA) to determine dietary offerings, financial assessments, participation rates, and attitudes toward the program. Because more schools participate in the lunch program than participate in the breakfast program, and because more children participate in lunch than breakfast, only variables related to lunchtime eating were included in the analysis.

The SNDA is the federally approved evaluation of the National School Lunch Program (NSLP) and the School Breakfast Program (SBP). The SNDA-III data collection procedure utilized stratified sampling techniques (Gleason & Dodd, 2009). School food authorities (SFAs) (n=129) were randomly selected from public schools in the United States (Gordon et al., 2009). Principals and school food managers at one elementary, middle, and high school randomly selected from food authorities were surveyed (n=398 schools). Approximately eight students were randomly selected from each school (n=2,314) for the child and parent response data. The samples are representative of all public schools participating in the National School Lunch Program.

Previously published descriptive analysis of the SNDA-III data indicated that in NSLP schools, 46% of students were classified as an ethnic minority. Twenty-nine percent of the children were from families who qualified for the free lunch program (<130% of poverty) and an additional 13% qualified for reduced prices (130% - 185% of poverty); 18% of the children's families were considered food insecure by the USDA (Gordon et al., 2009).

Data Consolidation and Recoding Procedure

The six datasets containing responses from children (response and dietary recall), parents, school food authorities, principals, and school food managers were combined into a single data set

and variables under examination were selected. The following recoding procedures were conducted, which resulted in a final sample size of n=277:

1. Cases were selected in which the child indicated only a lunch, snack, or drink was consumed at school.
2. In order to accurately model the relationship between school environment and child's consumption, 239 cases were removed where matching on student id, school id, and sfa id was not possible.
3. Cases where the school does not participate in the NSLP were removed due to an extreme number of missing values on many of the variables.
4. Variables were deleted that contained high numbers of missing values.
5. Since the majority of response variables were dichotomous, other categorical and ordinal variables were recoded into dichotomous variables to facilitate summation into indices.
6. The variable WHROBT (indicates source of the food eaten) was recoded into a dichotomous variable (0=school, 1=home) due to extreme numbers of missing cases and low counts of other food sources (e.g., sporting events, fast food, ice cream truck), and to facilitate binary logistic regression analysis.
7. Dichotomous variables were recoded to reflect health-promoting factor = 1.
8. Summated indices were created for the physical eating environment, social eating environment, healthy food availability, competitive food availability, nutrition policies, health and wellness policies, and cultural norms independent variables.

Variables List

The following is the list of dependent variables and individual variables that were summated into the independent variable indices. Questions are coded according to the survey

from which they were taken: R - child dietary recall; C - child response; P - principal response; FSM - food service manager, and SFA - school food authority, and the question number/name from the respective survey. Variables labeled as ACF, or using other variable names, were created by researchers at Mathematica, Inc., based on on-site visits and evaluations of the schools.

Dependent Variables

Consumption of fruit, 100% fruit juice, vegetables

- R_Mealcode: Meal component fruit, 100% juice, vegetables (consumed=1)

Consumption of dessert

- R_Mealcode: Meal component dessert (consumed=1)

Independent Variables

Physical eating/food environment

- C_q29: Do you think your lunch period is too early in the day, too late, or is your lunch period time about right? (Response 1=About Right)
- C_q31: Would you say the tables are...? (Response 1=Always or Usually clean)
- C_q31a: Would you say the floor is...? (Response 1=Always or Usually clean)
- C_q32: Would you say there are usually plenty of seats and tables? (Response 1=Yes)
- C_q33: Would you say most of the time there are ...? (Response 1=Short or No lines)
- C_q36a: Do you always, often, sometimes, or never like the taste of the food? (Response 1=Always or Often)
- C_q36b: Do you always, often, sometimes, or never like the smell of the food? (Response 1=Always or Often)

- C_q36c: Do you always, often, sometimes, or never like the way the food looks? (Response 1=Always or Often)
- C_q40: Does the school lunch always, often, sometimes, or never have enough choices of food? (Response 1=Always or Often)

Social eating environment

- P2: Are students allowed to visit other tables during meal times? (Response 1=Yes)
- P8: Are other school activities, such as pep rallies, club meetings, bake sales, or tutoring sessions every scheduled during meal times? (Response 1=No)
- P10b: Are students allowed to go out to recess before the official end of their lunch period? (Response 1=No)
- P17: How often is the noise level at lunch a problem? (Response 1=Never or Seldom)
- C_q30: Would you say the place you eat your lunch is usually too noisy, too quiet, or about right? (Response 1=About Right)
- C_q34a: Do the food servers and cashiers always, often, sometimes, or never smile and say hello to you when you're getting school breakfast or lunch? (Response 1=Always or Often)
- C_q35: Do you get to pick where you sit and who you can eat with during your lunch period? (Response 1=Yes)

Availability of healthy foods

- SFA Q9: Does your district have guidelines on purchasing locally grown foods? (Response 1=Yes, state or local guidelines)
- SFA Q10a: Does your district have guidelines about purchasing fresh produce, other than locally grown foods? (Response 1=Yes, state or local guidelines)

- SFA Q11: Does your district purchase food through the Department of Defense “DoD Fresh program? (Response 1=Yes)
- SFA Q12: Does your district purchase foods through the “State Farm to School” program? (Response 1=Yes)
- ACF_15: Meals prepared off-site (Response 1=No)

Nutrition policies

- SFA Q1_1: Does your district use a computerized system for nutrient analysis of menus? (Response 1=Yes)
- SFA Q5: Do any of the schools in your district offer foods from national or regional brand-name or chain restaurants, such as McDonald’s, Burger King, Taco Bell, Pizza Hut, Domino’s, or Subway? (Response 1=No)
- SFA Q6: Is your school district, or are any schools in your district, engaged in a “pouring rights” contract? (Response 1=No)
- SFA Q7: Other than the USDA ban on selling soft drinks during meals, has your school district, or any school in your district, imposed a ban or restriction on the types of soda, soft drinks, or sweetened fruit beverages (less than 100% juice) that may be sold to students in schools or on school grounds (including vending machines)? (Response 1=Yes)
- SFA Q7a: Other than the USDA restrictions, has your school district, or any school in your district, set restrictions on the time of day when students may purchase soda, soft drinks, or sweetened fruit beverages in schools or on school grounds (including vending machines)? (Response 1=Yes)

- SFA Q7b: Other than USDA restrictions, has your school district, or any school in your district restricted the types of food or snack items sold to students in schools or on school grounds (including school stores and vending machines)? (Response 1=Yes)
- SFA Q13: Does your district include nutrition requirements in purchasing specifications for any foods? (Response 1=Yes)
- SFA Q14: Does your district require child nutrition (CN) or other nutrient labels on some or all purchased foods? (Response 1=Yes)

Availability of competitive foods

- P3b1-5: Which of the following off-campus food sources are close enough for students to walk or drive to during lunch? (Combined into one variable, Response 1=None)
- P23_0: Where are vending machines available to students in your school or on the school grounds? (Response 1=no vending machines for students)
- FSM_Q4: Are vending machines located in your food service area (that is, the indoor area where reimbursable meals are served/eaten)? (Response 1=No)
- P23b_1: Not counting machines that sell only milk, 100% juice, or water, when can students use the beverage machines outside of the food service area? (Response 1=No beverage machines outside of food service area)
- P23c: Are beverage sales in your school covered by a “pouring rights” contract? (Response 1=No)
- P23d_1: When can students use the snack machines or other machines containing snacks outside of the food service area? (Response 1=No machines with snack foods outside of the food service area)

- P25: Do you have a school store that sells foods or beverages (including snack foods)? (Response 1=No)
- P26: Outside of the food service area, do you have a school snack bar (that is, a place that prepares and service foods but does not offer reimbursable meals)? (Response 1=No)
- P27: Not counting any sales in the food service area during lunch, how often do school organizations sell sweet or salty snacks as fundraisers? (Response 1=Never)
- P27a: How often do school organizations sell pizza or other main entrée items during lunch? (Response 1=Never)
- SFAQ27_1: No a la carte items sold (Response =1)
- ACF_14: Availability of branded food (Response 1=None)
- Open_campus: (Response 1=No)

Overall health and wellness policies/activities

- SFA Q23a: Does your district have a wellness policy that addresses student nutrition and physical activity? (Response 1=Yes)
- SFA Q24: Does your department routinely make information on the nutrient content of USDA-reimbursable meals available to students and/or parents? (Response 1=Yes)
- FSM_q24: Does your school routinely make information on the nutrient content of USDA-reimbursable meals available to students or parents? (Response 1=Yes)
- SFA Q24b_a: In the past 12 months, have you or anyone on your staff attended a PTA or other parent group meeting to discuss the school food service program? (Response 1=Yes)

- FSM_q25_a: In the past 12 months, have you or anyone on your staff attended a PTA or other parent group meeting to discuss the school food service program? (Response 1=Yes)
- SFA Q24b_b: In the past 12 months, have you or anyone on your staff provided families with information about the school food service program, other than basic menu information? (Response 1=Yes)
- FSM_q25_b: In the past 12 months, have you or anyone on your staff provided families with information about the school food service program, other than basic menu information? (Response 1=Yes)
- SFA 24b_d: In the past 12 months, have you or anyone on your staff participated in a nutrition education activity in a classroom? (Response 1=Yes)
- FSM_25_d: In the past 12 months, have you or anyone on your staff participated in a nutrition education activity in a classroom? (Response 1=Yes)
- SFA 24b_e: In the past 12 months, have you or anyone on your staff conducted a nutrition education activity in a food service area? (Response 1=Yes)
- FSM_25_e: In the past 12 months, have you or anyone on your staff conducted a nutrition education activity in a food service area? (Response 1=Yes)
- P9: Does your school have recess? (Response 1=Yes)
- P31_1-8: Does your school participate in any of the following nutrition education programs? (Response 1=Yes)
- P32a: Is there a specific focus for nutrition education during this academic year? (Response 1=Yes)

- P33: Does your school have a wellness policy that addresses student nutrition and physical activity? (Response 1=Yes)
- P33b: Does your school have a nutrition or health advisory council that addresses issues and concerns related to nutritional or physical activity? (Response 1=Yes)

Cultural norms

- P1: Are all students scheduled to have a lunch period every day? (Response 1=Yes)
- P32: At what grade levels do your students study nutrition? (Response 1=Every grade)
- FSM_q14: Are different portion sizes available to different grade levels? (Response 1=Yes)
- C_q34: Do the food servers and cashiers always, often, sometimes, or never listen to you and other students? (Response 1=Always or Often)
- C_q37: Do you think the amount of food they give you is...? (Response 1=About right)

Individual Difference Variables

- WHROBT: Where did you get the lunch you ate (today/yesterday)? (Response 1= Home; 0=School)

Child's age -- C_Grade: Grade (open-ended)

Child's gender -- C_Gender: Gender (Response 1=Male; 0=Female)

BMIPCT: Child's BMI percentile (open-ended; measured by Mathematica, Inc. researchers during school site visit)

Grade level

- School Type: (1=K-2; 2=3-5; 3=6-8; 4=9-12)

Purchase of sweet snacks

- C_q19: Did you buy any other foods in school to go along with your regular school lunch, such as a drink, ice cream, or cookies? (Response 1=Yes)

Analysis Procedure

The SNDA-III data are primarily coded as binary measures to allow participants to provide as many response-options as possible. To facilitate analysis, summated indices were created to represent the independent variables. Analysis was conducted in two phases. In phase one, structural equation modeling using SPSS-AMOS (Chicago, IL) was used to explore hierarchical relationships between the dependent variables and independent variable indices and general model fit. In phase two, STATA 11 (StataCorp LP, College Station, TX) and PASW-17 (SPSS-IBM, Chicago, IL) were used to perform logistic regression analysis to determine fit of a reduced model and to determine coefficient weights for specific questions that comprised the independent variable indices.

RESULTS

The purpose of this study is to explore the relationships between factors in the school environment and children's food consumption. The SNDA-III data, the federal government's official assessment of the School Lunch program was analyzed to determine these relationships for fruit and vegetable consumption and for dessert consumption.

Fruit and vegetable consumption

In the structural equation model, the variables of age, sex, BMI percentile, and school type were examined as both indicators of the independent variables source of food, eating environment, social environment, availability of healthy food, availability of competitive food, nutrition policies, health and wellness policies, and cultural norms, and as direct predictors of fruit and vegetable consumption. Because this was an exploratory analysis of behavioral responses, $\alpha=0.10$ was used to determine statistical significance.

Results suggest that the age of the child and the grade level of the school are strong predictors of the school-eating environment (see Table 1). As expected, and as indicated in prior research, as children age and progress from elementary to middle and high school, they encounter more competitive food and more flexibility and options for food selection. Older children are also subject to fewer health-promoting nutrition policies at school and fewer health-promoting cultural norms. However, increasing grade level is related to a more health-promoting social environment during lunch.

Modeling of the independent variables as predictors of the fruit and vegetable consumption resulted in both counter-intuitive and expected results. Higher scores on the eating environment index predicted lower consumption of fruits and vegetables. However, higher

scores on the cultural norms index predicted greater consumption of fruits and vegetables (see Table 1).

Table 1 <i>Hierarchical Predictors of Fruit and Vegetable Consumption</i>				
Independent → Dependent	Est.	S.E.	C.R.	P
Age → competitive food	-0.092	0.043	-2.156	0.031
Age → nutrition policies	-0.126	0.047	-2.696	0.007
School Type → competitive food	-0.594	0.169	-3.522	<0.01
School Type → social environment	0.563	0.140	4.011	<0.01
School Type → cultural norms	-0.343	0.100	-3.424	<0.01
Eating Environment → Fruit Veg	-0.017	0.009	-1.792	0.073
Cultural Norms → Fruit Veg	0.052	0.022	2.342	0.019

Since the independent variables were summated indices, more in-depth understanding of the specific predictors was desired. Each individual variable within the eating environment and cultural norms indices, along with the individual factors of sex, age, source of food, school type, and BMI percentile were regressed on fruit and vegetable consumption using STATA (College Station, TX) to determine significance ($\alpha=0.10$). Within the eating environment index, three variables were significant predictors of fruit and vegetable consumption: cleanliness of floors, plenty of seats and tables, and whether the child likes the taste of the food (see Table 2).

Table 2
Eating Environment Predictors of Fruit and Vegetable Consumption

Variable	Coef.	S.E.	z	P> z	95% C.I.
Floors	-0.8812	0.4752	-1.85	0.064	-1.81, 0.05
Tables	0.9893	0.5914	1.67	0.094	-0.17, 2.15
Taste	-0.8826	0.5307	-1.66	0.096	-1.92, 0.16

Within the cultural norms index, the only significant variable was whether or not students study nutrition in every grade (see Table 3).

Table 3
Cultural Norms Predictors of Fruit and Vegetable Consumption

Variable	Coef.	S.E.	z	P> z	95% C.I.
Nutrition	0.9447	0.4743	1.99	0.046	0.02, 1.87

The dearth of significant findings when testing complex models of influence on children's fruit and vegetable consumption prompted additional binary logistic regression analysis of each independent variable index. Regression models were created for each index, not including the individual variables (sex, age, type of school, source of food, BMI percentile) included in prior analysis.

Analysis of the eating environment variables produced the same results as prior analysis; cleanliness of floors, cleanliness of tables, and taste of the food were statistically significant predictors of fruit and vegetable consumption (see Table 2).

Analysis of the cultural norms index revealed an additional significant predictor when the individual factors were not included. Nutrition education at every grade was a significant predictor, as well as whether different portion sizes are available to different grade levels (p=0.09).

Within the availability of healthy food index, the only significant predictor was whether the school district purchases food through the Department of Defense “DoD Fresh” program ($p=0.06$) (see Table 4). Availability of competitive food appears to have some predictive power. Within this index, the only significant predictors were whether off-campus food sources are close enough for students to walk to drive to during lunch ($p=0.00$) and whether vending machines are available to students in school or on school grounds ($p=0.035$).

School nutrition, health, and wellness policies were thought to influence children’s fruit and vegetable consumption. Within the nutrition policies index, the only significant predictor was whether any schools in the district offer foods from national or regional brand name or chain restaurants ($p=0.00$) (see Table 4). Within the health and wellness policies index, three variables predict fruit and vegetable consumption: (1) whether anyone on the school food service staff attended a PTA or parent group meeting to discuss the school food service program in the past 12 months ($p=0.08$), (2) whether anyone on the school food service staff conducted a nutrition education activity in the food service area in the past 12 months ($p=0.06$), and (3) whether the school participates in a recognized nutrition education program ($p=0.072$).

Individual difference factors were regressed as a group on fruit and vegetable consumption. Two variables were statistically significant predictors of consumption, the child’s age ($p=0.05$) and whether the child purchased other foods in school to go along with their regular school lunch (i.e., drink, ice cream, or cookies) ($p=0.04$) (see Table 4).

Table 4
Other Predictors of Fruit and Vegetable Consumption

Variable	Coef.	S.E.	z	P> z	95% C.I.
DoD Fresh	-1.5234	0.8197	-1.88	0.060	-3.11, 0.07
Close off-campus food	18.2882	1.8999	9.63	0.000	14.56, 22.01
Vending machines	1.4179	0.6729	2.11	0.035	0.10, 2.74
Branded foods	17.3398	0.7570	22.91	0.000	15.86, 18.82
Staff attend parent meeting	-1.6050	0.9143	-1.76	0.079	-3.40, 0.19
Nutrition education in food area	2.389	1.2756	1.87	0.061	-0.11, 4.89
School participation in nutrition education program	2.4925	1.3846	1.80	0.072	-0.22, 5.21
Child's age	-0.1391	0.0717	-1.94	0.052	-0.28, 0.00
Purchased other foods	-1.5964	0.7730	-2.07	0.039	-3.11, -0.08

Each of the significant index variables were then regrouped into a new model and regressed on fruit and vegetable consumption. Both STATA (College Station, TX) and PASW-17 (Chicago, IL) were used to conduct the analysis since each produces different model fit estimates for logistic regression. Coefficient estimates and significance were similar for each analysis (see Table 4). STATA analysis of this model produced a Log likelihood = -78.307214

and a pseudo $R^2 = 0.1757$. PASW-17 analysis produced a -2 Log Likelihood=152.449 and a pseudo R^2 (Nagelkerke R^2) = 0.229, indicating an adequate fit of the data to the model.

Clean floors in the eating area were associated with higher fruit and vegetable consumption (see Table 5). Influence by school food service staff on children's fruit and vegetable consumption was mixed. When school food service staff had discussed the food services program at a parent meeting in the last 12 months, children consumed more fruits and vegetables. Counterintuitive however, was the finding that if the food services staff conducted a nutrition education program in the school food area, children's consumption of fruits and vegetables was lower. If the school nutrition program was linked to a local hospital or university, the children consumed fewer fruits and vegetables. Finally, children who purchased other foods to go along with their lunch had higher fruit and vegetable consumption.

Table 5
Coefficient Estimates for Predictors of Fruit and Vegetable Consumption

Variable	B	S.E.	Wald	P> z
Clean floors	1.033	0.507	4.161	0.041
Staff attended parent meeting	1.604	0.865	3.439	0.064
Nutrition education programs	-2.234	0.973	5.268	0.022
Nutrition program linked to university or hospital	-2.078	1.079	3.710	0.054
Child bought other food to go along with lunch	1.434	0.807	3.156	0.076

Dessert consumption

Structural equation modeling was used to analyze the hierarchical relationships between the individual difference factor and independent variable indices and children's consumption of dessert (see Table 6). As indicated in the previous hierarchical analysis of fruit and vegetable consumption, child's age is negatively related to the availability of competitive foods and presence of school nutrition policies. Older children are subject to fewer nutrition policies and are more likely to have greater availability of competitive foods. School type, a proxy variable for grade level, is negatively related to three of the independent variable indices. As the grade level of the school increases, more competitive foods are made available to students, cultural norms support a less-healthy school environment, and students experience a more health-promoting social environment. The source of lunch food, the availability of healthy foods, and school nutrition policies are direct predictors of children's dessert consumption (see Table 6).

Table 6
Hierarchical Predictors of Dessert Consumption

Independent → Dependent	Est.	S.E.	C.R.	P
Age → competitive food	-0.092	0.043	-2.156	0.031
Age → nutrition policies	-0.126	0.047	-2.696	0.007
School type → competitive food	-0.594	0.169	-3.522	<0.01
School type → social environment	0.563	0.140	4.011	<0.01
School type → cultural norms	-0.343	0.100	-3.424	<0.01
Source of food → Dessert consumption	-0.162	0.038	-4.264	<0.01
Availability of healthy food → Dessert cons.	0.046	0.022	2.065	0.039
Nutrition policies → Dessert consumption	0.029	0.012	2.434	0.015

As with the analysis of fruit and vegetable consumption, each individual variable within the availability of health food and nutrition policies indices, along with the individual difference factors of age, sex, source of food, school type, and BMI percentile, were regressed on dessert consumption using STATA (College Station, TX) to determine significance ($\alpha=0.10$). Within the availability of healthy foods index, three variables were significant predictors of dessert consumption: whether the school district has guidelines on purchasing locally grown foods, whether the district purchases food through the Department of Defense “DoD Fresh” program, and the source of the food (see Table 7). Children were less likely to consume dessert if they attended schools within districts that had policies promoting purchase of locally grown foods or if the district purchased food through the DoD Fresh program. Children were less likely to consume dessert if they brought their lunch from home, than if they acquired their lunch at school.

Table 7
Healthy Food Availability Predictors of Dessert Consumption

Variable	Coef.	S.E.	z	P> z	95% C.I.
Local foods	1.7470	0.8119	2.15	0.031	0.16, 3.34
DoD Fresh	1.3637	0.8498	1.89	0.059	-0.05, 2.78
Source of food	-1.6127	0.4299	-3.75	0.000	-2.45, -0.77

Within the nutrition policies index, three environmental and three individual difference factors were significant predictors of a child’s dessert consumption (see Table 8). Children were less likely to consume dessert when they attended a school that uses a computerized system for nutrient analysis of menus and when they attended a school with a pouring rights contract. Children were more likely to consume dessert when they attended a school in a district that has

nutrition requirements for food purchases. Within of model of nutrition policies, boys were more likely to consume dessert than girls, children in older grades were more likely to consume dessert than children in younger grades, and children who acquired their lunch at school were more likely to consume dessert than children who brought their lunch from home.

Table 8
Nutrition Policy Predictors of Dessert Consumption

Variable	Coef.	S.E.	z	P> z	95% C.I.
Computerized nutrient analysis	1.3735	0.7218	1.90	0.057	-0.41, 2.79
Pouring rights contract	1.5596	0.7703	2.02	0.043	0.05, 3.07
Nutrition purchasing requirements	-1.9911	0.8167	-2.44	0.015	-3.59, -0.39
Sex	0.7644	0.4544	1.68	0.093	-0.13, 1.65
School type	1.0318	0.4432	2.33	0.020	0.16, 1.90
Source of food	-1.7670	0.4576	-3.86	0.000	-2.66, -0.87

As with the analysis of fruit and vegetable consumption, additional binary logistic regression analysis was conducted for each independent variable index. Regression models were created for each index, not including the individual variables (sex, age, type of school, source of food, BMI percentile) included in prior analysis.

Analysis of the healthy food availability variables produced the same results as prior analysis (see Table 7); children were less likely to consume dessert when the school district has policies for purchasing locally grown food and purchasing foods through the DoD Fresh program. One additional predictor was found in this analysis; children were more likely to

consume dessert when the district has guidelines about purchasing fresh produce, other than locally grown food ($p=0.083$).

Analysis of the nutrition policy index revealed the same results as before (see Table 8); children were less likely to consume dessert when the school used computerized nutrient analysis for menu planning and when schools in the district had a pouring rights contract. Children were more likely to consume dessert when the district included nutrition requirements in purchasing specifications for foods.

Within the index for health and wellness policies, if a district food services staff member attended a parent meeting to discuss food services, children were less likely to consume dessert ($p=0.080$) (see Table 9). However, if a school food staff member attended a parent meeting to discuss food services, children were more likely to consume dessert ($p=0.055$). Within the cultural norms index, the only significant predictor variable was children's perception of whether the food servers and cashiers listen to the students ($p=0.040$). Students consumed less dessert when they felt the food servers and cashiers listened to them. There were no significant predictor variables within the eating environment, social environment, or availability of competitive foods indices.

Table 9
Other Predictors of Dessert Consumption

Variable	Coef.	S.E.	z	P> z	95% C.I.
District food staff attend parent meeting	2.0780	1.1874	1.75	0.080	-0.25, 4.41
School food staff attend parent meeting	-1.1478	0.5990	-1.92	0.055	-2.32, 0.03
Servers and cashiers listen to students	1.1478	0.5595	2.05	0.040	0.05, 2.24

Each of the significant index variables were then regrouped into a new model and regressed on dessert consumption. Both STATA (College Station, TX) and PASW-17 (Chicago, IL) were used to conduct the analysis since each produces different model fit estimates for logistic regression. Coefficient estimates and significance were similar for each analysis (see Table 8). STATA analysis of this model produced a Log likelihood = -79.773644 and a pseudo $R^2 = 0.2114$. PASW-17 analysis produced a -2 Log Likelihood=159.476 and a pseudo R^2 (Nagelkerke R^2) = 0.273, indicating an adequate fit of the data to the model.

Children's dessert consumption appears to be influenced the most by district and school-level policies regarding food purchasing (see Table 10). Children were less likely to consume dessert if they attended a school in a district that has guidelines for purchasing locally grown foods and if the district purchases food through the DoD Fresh program. However, if the district includes nutrition guidelines in food purchasing and if the school food services staff made a presentation about food services at a parent meeting in the last 12 months, the children were more likely to consume dessert. Children who brought their lunch from home were less likely to consume dessert than children who acquired their food at school.

Table 10				
<i>Coefficient Estimates for Predictors of Dessert Consumption</i>				
Variable	B	S.E.	Wald	P> z
Local foods	-2.275	1.025	4.921	0.027
DoD Fresh	-1.488	0.840	3.140	0.076
Nutrition requirements in food purchase	1.252	0.750	2.789	0.095
Food service staff present at parent meeting	0.970	0.544	3.179	0.075
Food brought from home	-1.483	1.395	11.855	0.001

DISCUSSION

The purpose of this research was to enhance understanding of children's eating behaviors by examining the relationships between factors in the school environment and children's food consumption. Children consume a significant proportion of their daily caloric intake while in the school environment and the growing prevalence of childhood overweight and obesity has prompted researchers to reexamine this setting, in the hopes of identifying factors that influence children's eating behaviors.

Recently, public health and health promotion research have expanded their theoretical foci to models more indicative of the multi-factorial environment within which individual health behaviors occur. Similarly, the focus on children's eating behaviors has expanded as well, to look at the role of the school environment on children's food choices and consumption. The goal of this study was to take a broader analytical approach to the assessment of school lunches by examining influential linkages between environment and consumption of two types of food items that represent the spectrum of children's diets and the dietary goals most often advanced by nutrition experts, fruit and vegetable consumption and dessert consumption. Two of the most common recommendations and initiatives related to children's diets include increasing the consumption of fruits and vegetables and decreasing consumption of dessert and sweet snacks.

The ecological framework used in this study was based on a variety of recent literature advancing the idea that individuals' eating behaviors are highly influenced by ecological cues such as the physical environment (Cohen et al., 2000; Katz, 2009; Story et al., 2008; USDA, 2000; Wansink, 2004), the social environment (Wansink, 2004), cultural norms (Cohen et al., 2000; Katz, 2009), and food availability (Cohen et al., 2000; Finkelstein et al., 2008; Katz, 2009; Kubick et al., 2003; USDA, 2000). In previous research, the SNDA data were examined

primarily for evidence of nutritional content of school meals and children's selection of certain types of foods, and to build a model of school environment, but this is the first study to attempt linkage of school environment to child's consumption.

Analysis of the data revealed that children's lunchtime consumption of fruits and vegetables was influenced by a combination of environmental and policy-related factors. Children were more likely to consume fruits and vegetables if the floors in the eating area were clean. Wansink's (2004) research on atmospheric influences on eating suggested that factors such as lighting, odor, and noise create perceptual cues related to the desirability of the consumption experience. A clean eating environment in the school would naturally create a perception of a more enjoyable consumption experience for a child, which may increase the chances that a child is willing to eat certain foods. A clean environment may create and reinforce the perception of clean food.

Another environmental factor that influenced consumption of fruits and vegetables was whether the child bought other food to go along with his or her lunch. Availability of different types of foods obviously influences consumption, but this finding seems counter-intuitive at first. Much of the concern about availability of competitive foods in the school environment was related to children choosing energy-dense snack foods instead of healthier options (Cohen et al., 2000; Finkelstein et al., 2008; Katz, 2009; Kubick et al., 2003; USDA, 2000). While a complete understanding of this phenomenon will require further study, one possible explanation could relate to common nutritional messages that children receive. Young children are often encouraged at home to eat a "balanced" meal that includes a variety of foods, including dessert. Parents may motivate consumption of "healthier" foods by promising a reward of sweets if the healthier foods are consumed - "You can have a cookie if you eat all your broccoli." Parents may

give their child money to purchase a treat during school lunch to encourage the child to eat the lunch. These types of instructions and modeling may encourage children to develop an eating schema that expects inclusion of both fruits and vegetables and sweets in a meal, particularly for younger children.

The other environmental factors that influenced children's fruit and vegetable consumption were less intuitive, and related to food service policies and practices. Students were more likely to consume fruits and vegetables if a member of the School Food Authority (SFA) staff presented information about the food services program at a PTA or parent group meeting. However, students were less likely to consume fruits and vegetables if a member of the SFA staff conducted a nutrition education program in the food service area. These findings are interesting since it is logical to assume that school children would not be as familiar with an SFA staff member. School Food Authority employees work at the district level, rather than at the individual school level, so it seems children would be less familiar with an SFA staff member, than a member of their own school food services staff. If perhaps parents were bringing information home from an SFA staff presentation, they could encourage their children to consume more fruits and vegetables, or could make their child more aware of fruit and vegetable offerings, thus influencing consumption. Having an SFA staff member make a nutrition education presentation in the food service area may discourage consumption at the point of purchase, if the child feels directly pressured to consume fruits and vegetables, or feels like lunchtime is just another educational experience, rather than a respite from classroom activities.

Finally, children were less likely to consume fruits and vegetables if the nutrition program was linked to a hospital or university. This finding could be related to lack of familiarity, or lack of substantial marketing efforts for the nutrition program. If a nationally

recognized nutrition program is adopted in a school, often that program includes promotional materials such as posters and fliers. While a hospital or university-based nutrition program may be as scientifically sound as a national program, it may not have as many promotional resources, particularly if it is a local program, and the students may be less aware and less motivated by the program.

Nutritionists, researchers, and parents often look for ways to encourage children to consume less dessert and sweets. Results of this study conclude that lunchtime dessert consumption is related primarily to district and school-level policies regarding food purchasing, information sharing about the food services programs. Children were less likely to consume dessert if the school district had guidelines for purchasing locally grown foods and/or if the school district purchased food through the Department of Defense “DoD Fresh” program. These results may be indirectly attributed to the availability of fresh produce. Assuming that purchasing locally-grown foods and foods through the “DoD Fresh” program would result in greater availability, and perhaps greater variety, of fresh foods and produce, children at these schools may have other sweet options such as fresh fruit and the food programs may consequently be less likely to offer sweets such as ice cream or baked goods. It appears that some school district level guidelines on food purchasing may be an effective way to decrease children’s dessert consumption by providing healthier sweet alternatives, such as fresh fruit.

Children’s dessert consumption was also negatively related to whether the school district included nutrition requirements in food purchasing, and whether a school food service staff member made a presentation about the food program at a parent meeting. Children were more likely to consume dessert if there were nutritional purchasing guidelines and if the staff did make

a parent presentation. These findings are counter-intuitive and should motivate additional research to examine and confirm the relationships.

There was a single individual difference variable that was strongly related to dessert consumption. If the child acquired his or her lunch at school, rather than bringing it from home, the child was more likely to consume dessert. This finding could be related to the availability, and low cost, of dessert items at school. Many schools provide access to ice cream and baked goods either in the cafeteria line, or in a separate a la carte line. Children may have extra money from their lunch purchase to buy dessert, or may re-allocate their lunch money to less expensive items, in order to purchase dessert. Children who bring their lunch from home may not be provided with a dessert in their lunch. A child may not be given money to purchase a dessert at school, or may be unwilling to spend his or her own money for dessert. In this case, dessert may be more available and more convenient for those children purchasing a school lunch.

Surprisingly, other environmental factors commonly postulated as having influence on children's food choices did not produce significant findings in the analysis. The availability of competitive foods, such as sweets, soft drinks, and fast-food style items are often suggested as being negatively influential on a child's eating behavior (Cohen et al., 2000; Katz, 2009; Kubick, 2003; Wang et al., 2008). Many of the efforts at the national, state, and local levels to improve the school eating environment have focused on restricting access to competitive foods through elimination of school snack bars and food-based fundraisers, reduction in pouring rights contracts, and mandated changes to the availability of items such as sugar-sweetened beverages (Alliance for a Healthier Generation, 2009a, 2009b; Black, 2009; Harris, 2010; Poppendieck, 2010; Turner et al., 2010). Even the soft drink industry touts that its self-imposed reductions in

the availability of sugar-sweetened beverages in U.S. schools have resulted in 88% fewer calories in beverages available at school (American Beverage Association, 2010).

Factors in the physical and social eating environments are also suggested as having an influence on eating behaviors. Wansink (2004) suggests that physical cues such as light, noise, seating opportunities, and food salience can influence individuals' consumption because they influence perceptions of the desirability of the eating environment. Surprisingly, the only physical environment variable that demonstrated a significant relationship with food consumption in this study was relationship between cleanliness of floors and children's consumption of fruits and vegetables. None of the other physical environment variables were significantly related to consumption of either fruits and vegetables or dessert. The timing of recess in relation to lunch was also non-significant in influence on fruits and vegetable or dessert consumption. Timing of recess is growing as a variable of interest by researchers trying to understand how to create a healthier school environment.

Wansink (2004) and Cohen et al. (2000) postulated that cues within the social environment may also influence an individual's food consumption because they may distract an individual from paying attention to consumption, or they may reinforce social norms regarding consumption. None of the social environment variables examined in this study were related to children's fruit and vegetable or dessert consumption.

Implications

Understanding the relationships between the myriad of factors that influence children's food consumption is extremely challenging. Just like adults, children's food choices are influenced by so many different, inter-related factors such as the physical environment, social environment, cultural norms, media influence, and individual preferences. Children often cannot

provide a logical rationale of “why” they chose or consumed a particular food item, beyond simply that they “like it.” The growing prevalence of childhood overweight and obesity has forced researchers to examine children’s food consumption, in the hope of developing interventions that might teach and encourage children to make healthier food choices.

The school environment is seen as one context within which children’s food choices and consumption may be influenced. Children spend many hours each day in the school setting, and consume a significant portion of their daily calories while in this environment. Schools have the opportunity to not only make healthy food available to children, but also to teach children how to eat healthy. More than \$9 billion was spent on the National School Lunch (NSLP) and School Breakfast (SBP) Programs in 2008, and higher allocations are being requested as the U.S. Congress debates the reauthorization of the Child Nutrition Act of 2010. This significant amount of federal subsidy requires a careful consideration of how the money is being spent, and whether children are benefitting from the programs.

Based on this analysis of the USDA-sponsored evaluation of the school food programs (SNDA-III), there appears to be a significant disconnect between the factors researchers postulate as being influential to children’s food consumption, what is measured by the SNDA, and in reality, what does influence children’s consumption. Researchers have suggested that characteristics of the physical environment are highly influential on children’s food choices, and many resources have been spent to regulate the availability of energy-dense competitive foods in the school environment. However, policies contributing to the availability of competitive foods such as pouring rights contracts, vending machine availability, and branded-food availability were not significant influencers in this analysis.

School wellness policies, mandated by the federal government in the Child Nutrition and WIC Reauthorization Act of 2004 (Chiriqui et al., 2009), have also been proposed as important in creating healthier school environments. School wellness policies, as proposed by health experts, should include provisions on nutrition education, nutritional guidelines, competitive foods availability, and physical activity in schools. While research has demonstrated that many schools in the U.S. have not implemented adequate policies, as directed by the federal government (Chiriqui et al., 2009), this analysis found few relationships between nutrition and wellness policies and children's consumption of fruits and vegetables and dessert.

The lack of significance in this analysis of factors commonly theorized, and in some cases, previously found to be related to children's food consumption, is troubling. The purpose of this study was to examine the SNDA-III evaluation from an ecological perspective, to look at the relationship between school-based characteristics (as reported by school employees) and children's food consumption (as reported by the children). The lack of relationships between the variables prompts a call for a re-evaluation of this assessment.

The SNDA-III has been used to descriptively examine school characteristics, characteristics of children in schools participating in the NSLP and SBP, and to describe the nutrition composition of foods offered in school lunches and breakfasts (Briefel et al., 2009; Clark & Fox, 2009; Condon et al., 2009; Crepinsek et al., 2009; Gleason & Dodd, 2009). The assessment contains many questions that evaluate environmental factors that have been proposed as influential to children's food consumption; however, very few studies of these variables have been published (Finkelstein et al., 2008).

Millions of dollars are spent annually on school food programs and as a nation we are dependent upon the SNDA for evaluating these programs. Perhaps it is time to re-assess our

assessment, and determine if it measures the factors we need measured in order to completely understand the school food environment. We have adopted an ecological perspective to understanding how environmental factors influence food choices for both adults and children. We need an assessment that adequately measures the appropriate environmental factors in the school environment, as well as an assessment that is designed to test the relationships between environmental factors and children's food choices. At the present time, the SNDA does not provide an effective means by which to do this.

First Lady Michelle Obama's *Let's Move* initiative provides an opportunity to advocate for a better assessment of our school food programs. *Let's Move* seeks to "solve the problem of childhood obesity within a generation" by advocating for policies, actions, and funding to address the environmental risk factors commonly associated with childhood overweight and obesity (White House Task Force on Childhood Obesity, 2010). One of the priority areas for *Let's Move* is healthy food in schools. Some of the Task Force recommendations regarding healthy food in schools include:

1. Updating and improving nutritional standards for foods served in school.
2. Increasing resources for school meals, including reimbursements for food.
3. Providing resources and encouragement for training school food service professionals.
4. Providing resources for schools that want to update their school food facilities and equipment.
5. Develop creative ways to encourage children to choose healthier foods.
6. Connect school food services with local farmers.
7. Align competitive food offerings with nutritional guidelines.
8. Increase availability and consistency of nutrition education programs in schools.

9. Help schools understand how the school eating environment can influence children's food choices and consumption.
10. Encourage schools to create and implement school wellness policies.

These recommendations align with recognized theories of how environmental factors influence children's food choices and eating behaviors, and with the factors this study attempted to examine. If resources are going to be invested in re-design of the school eating environment, and encouragement of healthy food choices at school, then the perfect opportunity exists to re-examine our assessment of the school food environment at the same time, to reduce the chances of resources being wasted due to inadequate evaluation.

Limitations

The failure of the analysis of the SNDA-III dataset to provide evidence supporting common theories of the relationships between school eating environment factors and children's food consumption is largely attributable to the design of the assessment. Comprehensiveness is achieved through the use of different surveys for the school authority, school principal, school food service manager, children, and parents, but linking the responses of the child to the school environment is difficult and results in a significant loss of data. In this analysis, when individual children's responses were linked with those of the school principal, food service manager, and school food authority, the data set was reduced from over 4,000 responses to only 277, resulting in very small sample sizes when examining some variables.

The SNDA-III survey utilizes self-reported measures. Self-reports may result in underreporting and misreporting due to memory and estimation errors (IOM, 2007). However, the survey is considered to be the most valid and reliable assessment of school food programs in the U.S. due to its representative sampling.

Consumption of food items used as dependent variables was low, resulting in small sample sizes. Of the 277 children included in the analysis, only 30 (10.8%) indicated they consumed a fruit or vegetable on the day of, or the day prior to, the dietary recall. Only 33 children (11.9%) said they consumed a dessert. An examination of all the children's reports of food items included in the dietary recall resulted in questionable data. The meal component category garnering the highest response was the meat/meal alternative category, with 34.7 percent of children reporting they consumed food within this category on the day of, or day prior to, the recall. The positive responses for food categories consumed appear to be subject to significant under-reporting.

Another significant challenge to analysis of the SNDA-III data was the dichotomous nature of the survey responses. Most of the questions on the various surveys were coded as dichotomous variables. While binary responses allow respondents to maximize the answer possibilities, they weaken the analysis potential of the data, particularly for constructing hierarchical models.

CONCLUSION

The purpose of this research was to conduct an analysis of the relationship between the school eating environment and children's food consumption. An ecological perspective was used, hypothesizing that children's food consumption was related to factors attributable to the physical environment, the social environment, the availability of competitive and healthy foods, school nutrition and wellness policies, and cultural norms. The SNDA-III dataset was examined since it is the USDA-sponsored evaluation of the National School Lunch and School Breakfast Programs. The challenges of the SNDA-III dataset limited a comprehensive analysis of the relationship between factors in the school-eating environment and children's food consumption and findings did not support commonly accepted theories of influential environmental factors. More research is needed to better understand the comprehensiveness and inter-relationships between factors in the school eating environment and children's food choices. Additionally, a re-assessment of the appropriateness and relevance of the SNDA to an ecological perspective is needed.

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APPENDICES

Appendix A: Institutional Review Board Letter of Study Approval



Office of Research and Sponsored Programs
201J University Hall
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Dayton, OH 45435-0001
(937) 775-2425
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DATE: July 1, 2010

TO: Sabrina M. Neeley, Ph.D., Asst. Prof.
Community Health - Center for Global Health
Sara Paton, Ph.D., Asst. Prof.
Community Health - Center for Global Health

FROM: B. Laurel Elder, Chair 
WSU Institutional Review Board

SUBJECT: SC# 4239

The Influence of School Eating Environment on Children's Eating Behaviors: An Examination of the SNDA-III

At the recommendation of the IRB Chair, your study referenced above has been recommended for exemption. Please note that any change in the protocol must be approved by the IRB; otherwise approval is terminated.

This action will be referred to the Full Institutional Review Board for ratification at their next scheduled meeting.

NOTE: This approval will automatically terminate one (1) year after the above date unless you submit a "continuing review" request (see http://www.wright.edu/rsp/IRB/CR_sc.doc) to RSP.

If you have any questions or require additional information, please call Robyn Wilks, IRB Coordinator at 775-4462.

Thank you!

Enclosure

RESEARCH INVOLVING HUMAN SUBJECTS

SC# 4239

ACTION OF THE WRIGHT STATE UNIVERSITY
EXPEDITED REVIEW

Assurance Number: FWA00002427

Title: 'The Influence of School Eating Environment on Children's Eating Behaviors: An Examination of teh SNDA-III'

Principal Investigator: Sabrina M. Neeley, Ph.D., Asst. Prof.
Community Health - Center for Global Health
Sara Paton, Ph.D., Asst. Prof.
Community Health - Center for Global Health

The Institutional Review Board Chair has approved an exemption with regard to the use of human subjects on this proposed project.

REMINDER: Federal regulations require prompt reporting to the IRB of any changes in research activity [changes in approved research during the approval period may not be initiated without IRB review (submission of an amendment), except where necessary to eliminate apparent immediate hazards to subjects] and prompt reporting of any serious or on-going problems, including unanticipated adverse reactions to biologicals, drugs, radioisotope labeled drugs or medical devices.

B. Laurel Elder Ph.D.
Signed _____ Chair, WSU-IRB
Approval Date: July 01, 2010
IRB Mtg. Date: July 19, 2010

Appendix B : Linkage to Public Health Competencies

This research project achieved completion to the following Public Health Competencies (Competencies Project, Council on Linkages, April 2001):

- I. Analytic/Assessment Skills
 - a. Defines a problem
 - b. Determines appropriate uses and limitations of both quantitative and qualitative data
 - c. Selects and defines variables relevant to defined public health problems
 - d. Identifies relevant and appropriate data and information sources
 - e. Evaluates the integrity and comparability of data and identifies gaps in data sources
 - f. Makes relevant inferences from quantitative and qualitative data
 - g. Recognizes how the data illuminates ethical, political, scientific, economic, and overall public health issues
- II. Policy Development/Program Planning
 - a. Collects, summarizes, and interprets information relevant to an issue
- III. Communication Skills
 - a. Communicates effectively both in writing and orally, or in other ways
 - b. Advocates for public health programs and resources
 - c. Effectively presents accurate demographic, statistical, programmatic, and scientific information for professional and lay audiences
- IV. Basic Public Health Sciences Skills
 - a. Defines, assesses, and understands the health status of populations, determinants of health and illness, factors contributing to health promotion and disease prevention, and factors influencing the use of health services
 - b. Identifies and applies basic research methods used in public health
 - c. Applies the basic public health sciences including behavioral and social sciences, biostatistics, epidemiology, environmental public health, and prevention of chronic and infectious diseases and injuries
 - d. Identifies and retrieves current relevant scientific evidence
 - e. Identifies the limitations of research and the importance of observations and interrelationships
 - f. Attitudes: Develops a lifelong commitment to rigorous critical thinking